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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Applicants: Roger R. Lesieur
Serial No.: 09/332,415
Filed: June 14, 1999
For: "Compact Light Weight Methanol Autothermal Reformer Assembly"

Docket No.: C-2354
Group: 1764
Examiner: B. Ridley

APPEAL BRIEF UNDER RULE 192

Hon. Commissioner of Patents and Trademarks
Washington, D.C. 20231

Dear Sir:

This is an appeal brief appealing from the decision of the Examiner dated December 27, 2000 finally rejecting claims 1, 2, 7, 9, 12-20, 22 and 23 and 9-19, 21 and 22.

(1) REAL PARTIES IN INTEREST:
International Fuel Cells, LLC, South Windsor, CT

(2) RELATED APPEALS AND INTERFERENCES:
None.

(3) STATUS OF CLAIMS:
Claims 1-23 were originally submitted for examination. Claims 3-6, 8, 10, 11 and 21 have been canceled without prejudice. Claims 1, 2, 7, 9, 12-14, 17, 20, 22 and 23 have been amended. Presently, Claims 1, 2, 7, 9, 12-20, 22 and 23 have been finally rejected. The final rejections of claims 1, 2, 7, 9, 12-20, 22 and 23 are appealed herein.

(4) STATUS OF AMENDMENTS:

All amendments have been entered, or will be entered upon the filing of this appeal brief.

(5) SUMMARY OF THE INVENTION:

The invention relates to a methanol and ethanol fuel gas autothermal reformer assembly (3) which includes a monolithic open cell foam catalyst bed (2), the cells of which are coated with a catalyst (catalyzed). The catalyst bed includes an inlet end (8) and an outlet end (10), and an inlet region of said catalyst bed is provided with a catalyst which is operable to combust a portion of the fuel gas so as to raise the temperature of the catalyst bed to a temperature of at least 200°F. The operating temperature of the assembly is maintained in the range of 300°F to 500°F. A fuel gas inlet passage (44) is included, and the fuel gas inlet passage is disposed in heat exchange relationship with a processed fuel gas stream disposed in an outlet passage (22) from the catalyst bed whereby heat will be transferred to the fuel gas inlet passage from the processed fuel gas stream (D). An air inlet passage (46) is disposed in heat exchange relationship with the processed fuel gas stream (D) whereby heat from the processed fuel gas stream will be transferred to said air inlet passage. A fuel gas reforming catalyst is deposited in the foam catalyst bed. The assembly preferably includes a source of electricity to heat up the foam catalyst bed to operating temperatures at start up of the reformer assembly.

FIGS. 1 and 2 illustrate the aforesaid structure of the reformer and of the catalyst bed, and pages 3-11 of the specification describe the aforesaid structure and how to make the structure.

(6) ISSUES:

A. Does the use of the phrase "the processed gas stream" render the subject matter of Claim 1 unclear?

B. Does the phrase "said noble metal catalyst" in Claim 9 have sufficient antecedence?

C. Is the Markush recitation of catalysts contained in Claim 9 indefinite?

D. Is the subject matter of Claim 23 rendered obvious by the combined teachings of Clawson, Narumiya et al and Setzer '484?

E. Is the subject matter of Claims 1, 2, 7, 9, 12-20 and 22 rendered obvious by the combined teachings of Clawson, Narumiya et al, Setzer et al '484, and Dicks?

F. Is the subject matter of Claims 13-15 rendered obvious by the combined teachings of Clawson, Narumiya et al, Setzer et al '484, Dicks, and Sheller?

G. Is the subject matter of Claim 18 rendered obvious by the combined teachings of Clawson, Narumiya et al, Setzer et al '484, Dicks, and Bhattacharyya et al?

(7) GROUPING OF CLAIMS:

Claims 23 and 18 each stand or fall separately; Claims 13-15 stand or fall together; and Claims 1, 2, 7, 9, 12, 16, 17, 19, 20 and 22 stand or fall together. The patentability of each of the four sets of claims over the cited prior art will be argued separately.

(8) THE ARGUMENT:

The Examiner's Rejections:

The use of the phrase "catalyzed cells" renders the specification unclear. The use of the phrase "the fuel gas" in Claims 1-7, 9-18, 21 and 22 does not have sufficient antecedence, and therefore renders the claims unclear. The use of the phrase "catalyzed cells" in Claims 1, 21 and 22 renders these claims indefinite. The inclusion of the phrase "the processed gas stream" in Claims 1 and 21 renders these claims indefinite. The subject matter of Claim 19 is rendered obvious by the combined teachings of Clawson and Narumiya et al. The subject matter of Claims 1-6, 9-12 and 16-18 is rendered obvious by the combined teachings of Clawson, Narumiya et al and Setzer et al '484. The subject matter of Claims 13-15 is rendered obvious by the combined teachings of Clawson, Narumiya et al, Setzer et al '484 and Sheller. The subject matter of Claims 1, 7 and 21 is rendered obvious by the combined teachings of

Clawson, Narumiya et al and Setzer et al '578. The subject matter of Claim 22 is rendered obvious by the combined teachings of Setzer et al '578 and Narumiya et al.

The References Relied Upon:

U.S. Patent No. 3,904,554 Dicks, granted 9-9-75;
U.S. Patent No. 4,308,233 Narumiya et al, granted 12-29-81;
U.S. Patent No. 4,415,484 Setzer et al, granted 11-15-83;
U.S. Patent No. 5,384,099 Sheller, granted 1-24-95; and
WO 98/08771 Clawson, published 3-5-98.

A Brief Description Of The References:

The Dicks reference discloses a

The Narumiya et al reference discloses a device for purifying exhaust gas, such as a smelly gas, a carbon monoxide gas or the like which is produced by small sized internal combustion equipment. The device 1 includes a ceramic porous body 3 which includes a plurality of interconnected voids 2 and cell strands 3a covered with activated alumina 4 which in turn is covered by a noble metal catalyst layer 5. The gas stream being purified by the device has its noxious components oxidized by the catalyst or the smelly components can be absorbed by the activated alumina coating on the cell strands. (See Col. 6, line 47 through Col. 7, line 3). Thus CO will be oxidized to CO_2 if a carbon monoxide laden gas stream is being purified; or if a smelly gas stream is being purified, the activated alumina layer is said to surely absorb smelly components in the gas stream. The catalyst in Narumiya et al is thus either an oxidizing catalyst or an absorbent catalyst, thus the Narumiya et al exhaust gas stream purifier uses either oxidization of gas stream components, or absorption of gas stream components.

The Setzer et al '484 reference describes a catalytic steam-fuel gas stream reformer which utilizes an alumina pellet catalyst bed. The alumina pellets are impregnated by calcia (calcium oxide). The calcia-impregnated alumina pellets are coated with a rhodium catalyst. The operating temperature of the reformer appears to be about

1,360°F (see Col. 4, line 10).

The Sheller reference discloses a component of a catalytic converter core which is electrically heatable and which is coated with a catalyst that promotes oxidation of pollutants in an internal combustion engine or turbine exhaust stream. For example, carbon monoxide in the exhaust is oxidized to carbon dioxide. The pollutants are in essence burned in the converter. The reference also discloses a catalytic converter core which is made up of a plurality of the aforesaid components.

The Clawson reference discloses a hydrocarbon steam reformer for converting the hydrocarbon fuel to hydrogen and carbon dioxide. A mixture of fuel and steam enters a helical tube 32 along with air from an oxygen source 42. The air-steam-fuel mixture is fed into a partial oxidation zone 24 in the reformer where a portion of the fuel is burned to heat the reformer up. The zone 24 operates at a temperature of at least about 1,700°F (950°C) as noted on page 12 of the reference. A granular catalyst bed 28 forms a steam reforming zone 26 which is down stream from the zone 24. The air-steam-fuel mixture flows upwardly through the reforming zone 26 and then flows downwardly in heat exchange relationship with the helical tube 32. The reformed gas, or process gas, then passes through two shift converter beds 64 and 84 and then it leaves the reformer assembly.

The Rejections and Objections:

The following is a quotation of the rejections put forth by the Examiner in the final rejection dated December 27, 2000.

Claims 1-19 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claim(s) 1 recite(s) the limitation(s) "the processed gas stream" (line(s) 15). There is insufficient antecedent basis for said limitation(s) in the claim(s).

Claim(s) 9 recite(s) the limitation(s) "said noble metal catalyst" (line(s) 1-2). There is insufficient antecedent basis for this limitation in the claim.

Claim 9 states the limitation "selected from the group consisting of platinum, palladium and rhodium, and mixtures thereof". This claim is indefinite, as the alternative expressions are in a form of improper Markush group. Suggested correction: 'selected from the group consisting of platinum, palladium, rhodium, and mixtures thereto'.

Claim Rejections - 35 USC § 103

Claim 23, as best understood, are (is) rejected under 35 U.S.C. 103(a) as being unpatentable over Clawson (WO 98/08771), in view of Narumiya et al. (USP 4,308,233) and further in view of Setzer et al. (USP 4,415,484). Regarding claim(s) 23 Clawson discloses a similar autothermal reformer assembly (Fig. 3), the assembly comprising:

a) a catalyst bed (200), said catalyst bed including an inlet end (2 1 0) and an outlet end (270), an inlet portion of said catalyst bed being operable to combust a portion of the methanol fuel gas (P20/L23-24) thereby enabling start up of the reformer assembly while inhibiting carbon deposition in catalyzed cells of said foam catalyst bed (P24/L 1 -7 & P5/L 1 2-19). While Clawson does disclose using a supported catalyst in the catalyst bed, the reference does not explicitly disclose said catalyst being supported on a monolithic open cell foam.

Narumiya et al. teaches a catalyst bed comprising: a monolithic open cell foam core (Fig. 1, C4/L30-32). It would have been obvious to one having ordinary skill in the art at the time the invention was made to use a monolithic open cell foam core structure, as taught by Narumiya et al., as a support for the catalyst in the assembly of Clawson, for the purpose of providing structure which allows the fuel gas to always be in contact with the surface of the catalyst to accelerate gas diffusion and to prevent the direct passage of unreacted gas.

While Clawson does disclose combusting portion of the fuel gas in the inlet region of

the reactor for the purpose of rising the temperature of the of the fuel gas stream and enabling start up of the reformer assembly (P24/LI-7), the reference does not explicitly disclose said inlet region being provided with a noble catalyst which is operable to combust a portion of the fuel gas stream at a temperature of about 200°F.

Setzer et al. teaches an inlet portion of a catalyst bed being provided with a catalyst which is operable to combust a portion of the fuel gas stream at a temperature of about 200oF (C4/L29-66).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to provide a noble catalyst which is operable to combust a portion of the fuel gas stream at a temperature of about 200°F, as taught by Setzer et al., in the inlet portion of the catalyst bed of Clawson, for the purpose of allowing greater flexibility in the maximum allowable reactor temperature and the method of introducing the air into the reactor.

Claims 1-2, 7, 9, 12-20 and 22, as best understood, are rejected under 35 U.S.C. 103(a) as being unpatentable over Clawson (WO 98/08771), in view of Narumiya et al. (USP 4,308,233), further in view of Setzer et al. (USP 4,415,484) and further in view of Dicks (USP 3,904,554).

Regarding claim(s) 1 Clawson discloses a similar autothermal reformer assembly (Fig. 3), the assembly comprising:
a) a catalyst bed (200), said catalyst bed including an inlet end (210) and an outlet end (270), a first inlet region of said catalyst bed being operable to combust a portion of the fuel gas stream so as to raise the temperature of said fuel gas stream in said first region to a temperature in the range of about 300° to about 500°F while inhibiting carbon deposition in catalyzed cells of said foam catalyst bed (P24/L1-7 & P5/L12-19), and said catalyst bed further including a subsequent region which contains a catalyst (225);
b) a fuel gas stream inlet passage (208), said fuel gas stream inlet passage (208) being disposed in heat exchange relationship with a process gas stream outlet

passage from said catalyst bed whereby heat is transferred to said fuel gas stream inlet passage from the processed gas stream (P20/L7-11 & P21/L7-10);
c) an air inlet passage (232), said air inlet passage being disposed in heat exchange relationship with the process gas stream whereby heat from the process gas stream is transferred to said air inlet passage (P22/L13-15); and
d) a fuel gas stream reforming catalyst (225) deposited in said catalyst bed (200).

While Clawson does disclose using a supported catalyst in the catalyst bed, the reference does not explicitly disclose said catalyst being supported on a monolithic open cell foam.

Narumiya et al. teaches a catalyst bed comprising: a monolithic open cell foam core (Fig. 1, C4/L30-32).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to use a monolithic open cell foam core structure, as taught by Narumiya et al., as a support for the catalyst in the assembly of Clawson, for the purpose of providing structure which allows the fuel gas to always be in contact with the surface of the catalyst to accelerate gas diffusion and to prevent the direct passage of unreacted gas.

While Clawson does disclose combusting portion of the fuel gas in the inlet region of the reactor for the purpose of rising the temperature of the of the fuel gas stream (P24/L1-7), the reference does not explicitly disclose said inlet region being provided with a catalyst which is operable to combust a portion of the fuel gas.

Setzer et al. teaches an inlet portion of a catalyst bed being provided with: a catalyst which is operable to combust a portion of the fuel gas (C4/L29-66).
it would have been obvious to one having ordinary skill in the art at the time the invention was made to provide a catalyst which is operable to combust a portion of the fuel gas, as taught by Setzer et al., in the inlet portion of the catalyst bed of Clawson, for the purpose of allowing greater flexibility in the maximum allowable reactor

temperature and the method of introducing the air into the reactor.

While Clawson does disclose and said catalyst bed further including a subsequent region which contains a catalyst (225), the reference does not explicitly disclose said subsequent region which contains a copper and/or zinc catalyst.

Dicks teaches a steam reforming process wherein reforming region contains a copper and/or zinc catalyst (Abstract & C5/L7-10).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to provide a copper and/or zinc catalyst, as taught by Dicks, in the reforming region of the reformer of Clawson, for the purpose of providing a catalyst which is more resistant to poisoning by sulfur than other catalysts, usually containing nickel, which are generally used in steam reforming process.

Regarding claims 2, 7 and 9, Clawson, in view of Narumiya et al., further in view of Setzer et al. and further in view of Dicks disclose all the claim limitations as set forth above. Additionally Setzer et al. teaches an autothermal reformer assembly, wherein:
said catalyst in said first region of said catalyst bed includes a noble metal and calcium oxide (C2/L5-6 & C4/L29-66);
said first region of said catalyst bed contains an iron oxide catalyst in combination with calcium oxide (C4/L29-66);
said noble metal catalyst is a catalyst selected from the group consisting of platinum, palladium, rhodium and mixtures thereof.

Regarding claim 12, Clawson, in view of Narumiya et al., further in view of Setzer et al. and further in view of Dicks disclose all the claim limitations as set forth above. Additionally Narumiya et al. teaches an assembly, wherein:
said foam core catalyst bed includes at least one ceramic foam support body (C2/L45-49).

Regarding claims 16-17 and 19, Clawson, in view of Narumiya et al, further in view of

Setzer et al. and further in view of Dicks disclose all the claim limitations as set forth above. Additionally Clawson discloses an autothermal reformer assembly, wherein: - said catalyst bed is cylindrical in shape (Fig. 3); said fuel gas stream inlet passage (208) contains a fuel gas/steam mixture (P20/L7-9); - said fuel gas is methanol (P20/L23-24).

Regarding claim(s) 20 Clawson discloses a similar autothermal reformer assembly (Fig. 3), the assembly comprising:
a) a cylindrical catalyst bed (200), said catalyst bed including an inlet end (210) and an outlet end (270);
b) a fuel gas/steam mixture inlet passage (208, P20/L7-9);
c) a fuel gas reforming catalyst (225) deposited in said catalyst bed (200).
While Clawson does disclose using a supported catalyst in the catalyst bed, the reference does not explicitly disclose said catalyst being supported on a monolithic open cell foam.

Narumiya et al. teaches a catalyst bed comprising: a monolithic open cell foam core (Fig. 1, C4/L30-32).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to use a monolithic open cell foam core structure, as taught by Narumiya et al., as a support for the catalyst in the assembly of Clawson, for the purpose of providing structure which allows the fuel gas to always be in contact with the surface of the catalyst to accelerate gas diffusion and to prevent the direct passage of unreacted gas.

While Clawson does disclose combusting portion of the fuel gas in the inlet region of the reactor for the purpose of rising the temperature of the of the fuel gas stream (P24/L1-7), the reference does not explicitly disclose said inlet region being provided with a noble metal catalyst which is operable to combust a portion of the fuel gas.
Setzer et al. teaches an inlet portion of a catalyst bed being provided with:
a noble metal catalyst which is operable to combust a portion of the fuel gas (C4/L29-

66).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to provide a catalyst which is operable to combust a portion of the fuel gas, as taught by Setzer et al., in the inlet portion of the catalyst bed of Clawson, for the purpose of allowing greater flexibility in the maximum allowable reactor temperature and the method of introducing the air into the reactor.

While Clawson does disclose and said catalyst bed further including a subsequent region which contains a catalyst (225), the reference does not explicitly disclose said subsequent region which contains a copper and/or zinc catalyst.

Dicks teaches a steam reforming process wherein reforming region contains a copper and/or zinc catalyst (Abstract & C5/L7-10).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to provide a copper and/or zinc catalyst, as taught by Dicks, in the reforming region of the reformer of Clawson, for the purpose of providing a catalyst which is more resistant to poisoning by sulfur than other catalysts, usually containing nickel, which are generally used in steam reforming process.

Regarding claim(s) 22 Clawson discloses a similar autothermal reformer assembly (Fig. 3), the assembly comprising:
a) a catalyst bed (200), said catalyst bed including an inlet end (210) and an outlet end (270), an inlet portion of said catalyst bed being operable to combust a portion of the fuel gas thereby enabling start up of the reformer assembly while inhibiting carbon deposition in catalyzed cells of said foam catalyst bed (P24/L1-7 & P5/L12-19);
b) a fuel gas stream inlet passage (208), said fuel gas stream inlet passage (208) being disposed in heat exchange relationship with a process gas stream outlet passage from said catalyst bed whereby heat is transferred to said fuel gas stream inlet passage from the processed gas stream (P20/L7-11 & P21/L7-10);
c) an air inlet passage (232), said air inlet passage being disposed in heat exchange

relationship with the process gas stream whereby heat from the process gas stream is transferred to said air inlet passage (P22/13-15); and
d) a fuel gas stream reforming catalyst (225) deposited in said catalyst bed (200).

While Clawson does disclose using a supported catalyst in the catalyst bed, the reference does not explicitly disclose said catalyst being supported on a monolithic open cell foam.

Narumiya et a]. teaches a catalyst bed comprising: a monolithic open cell foam core (Fig. 1, C4/L30-32).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to use a monolithic open cell foam core structure, as taught by Narumiya et al., as a support for the catalyst in the assembly of Clawson, for the purpose of providing structure which allows the fuel gas to always be in contact with the surface of the catalyst to accelerate gas diffusion and to prevent the direct passage of unreacted gas.

While Clawson does disclose combusting portion of the fuel gas in the inlet region of the reactor for the purpose of rising the temperature of the of the fuel gas stream and enabling start up of the reformer assembly (P24/L1-7), the reference does not explicitly disclose said inlet region being provided with a noble catalyst which is operable to combust a portion of the fuel gas stream at a temperature of about 200°F.

Setzer et al. teaches an inlet portion of a catalyst bed being provided with: a catalyst which is operable to combust a portion of the fuel gas stream at a temperature of about 200°F (C4/L29-66).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to provide a noble catalyst which is operable to combust a portion of the fuel gas stream at a temperature of about 200°F, as taught by Setzer et al., in the inlet portion of the catalyst bed of Clawson, for the purpose of allowing greater

flexibility in the maximum allowable reactor temperature and the method of introducing the air into the reactor.

While Clawson does disclose and said catalyst bed further including a subsequent region which contains a catalyst (225), the reference does not explicitly disclose said subsequent region which contains a copper and/or zinc catalyst.

Dicks teaches a steam reforming process wherein reforming region contains a copper and/or zinc catalyst (Abstract & C5/L7-10).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to provide a copper and/or zinc catalyst, as taught by Dicks, in the reforming region of the reformer of Clawson, for the purpose of providing a catalyst which is more resistant to poisoning by sulfur than other catalysts, usually containing nickel, which are generally used in steam reforming process.

Claims 13-15, as understood, are rejected under 35 U.S.C. 103(a) as being unpatentable over Clawson (WO 98/08771), in view of Narumiya et al. (USP 4,308,233), further in view of Setzer et al. (USP 4,415,484) and further in view of Dicks (USP 3,904,554), as applied to claims 1-2, 7, 9 and 12-19 above, and further in view of Sheller (USP 5,384,099).

Clawson, in view of Narumiya et al., further in view of Setzer et al. and further in view of Dicks disclose all the claim limitations as set forth above, but the references (do) not disclose the catalyst bed comprising a high temperature-compatible metal support connected to a source of electrical current so as to serve as a resistance heating element by being heated to operating temperature within about twenty seconds of applying electrical current thereto.

Sheller teaches a monolithic catalyst bed, wherein:
said catalyst bed includes an autothermal reformer-operating temperature-compatible metal support selected from the group consisting of stainless steel, nickel alloys and

iron-aluminum alloys (C1/L26-29);
said metal support is connected to a source of electrical current, so as to serve as a resistance heating element (C1/L52-63);
said metal support is electrically heated to operating temperature within about twenty seconds of applying electrical current thereto (C 1/L65-66).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to provide a high temperature-compatible metal support connected to a source of electrical current, as taught by Sheller, in the catalyst bed of Clawson, in view of Narumiya et al., further in view of Setzer et a]. and further in view of Dicks, for the purpose of activating the catalyst during the start up of the reformer.

Claims 18, as understood, are rejected under 35 U. S.C. 103(a) as being unpatentable over Clawson (WO 98/08771), in view of Narumiya et al. (USP 4,308,233), further in view of Setzer et al. (USP 4,415,484) and further in view of Dicks (USP 3,904,554), as applied to claims 1-2, 7, 9 and 12-19 above, and further in view of Bhattacharyya et al. (USP 5,498,370).

Regarding claims 18, Clawson, in view of Narumiya et al., further in view of Setzer et al. and further in view of Dicks disclose all the claim limitations as set forth above. Additionally Clawson discloses an autothermal reformer assembly, wherein: said air inlet passage contains air (P23/L19-22). Clawson does not explicitly disclose said air inlet passage containing an air/steam mixture.

Bhattacharyya et al. (discloses?) a process using steam as a temperature modifier and to avoid soot formation in partial oxidation of hydrocarbons (C2/L53-55).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to add steam, as taught by Bhattacharyya et al. to said air inlet passage of Clawson, for the purpose of using the steam as a temperature modifier and to avoid soot formation.

Double Patenting

The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. See In re Goodman, F.3d 1046, 29 USPQ 2d 2010 (Fed.Cir. 1993); In re Longi, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); In re Van Ornum, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); In re Vogel, 422 F.2d 438,164 USPQ 619 (CCPA 1970); and, In re Thorington, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) may be used to overcome an actual or provisional rejection based on a nonstatutory double patenting ground provided the conflicting application or patent is shown to be commonly owned with this application. See 37 CFR 1.130(b).

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CF.R 3.73(b).

Claims 1-2, 7, 9, 12-18, 20 and 22 are provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-22 of copending Application No. 09/321,390 in view of Dicks (USP 3,904,554).

The copending application claims does (do?) not explicitly claim said subsequent region which contains a copper and/or zinc catalyst.

Dicks teaches a steam reforming process wherein reforming region contains a copper and/or zinc catalyst (Abstract & C5/L7-10).

It would have been obvious to one having ordinary skill in the art at the time the

invention was made to provide a copper and/or zinc catalyst, as taught by Dicks, in the reforming region of the reformer claimed by 09/321,390, for the purpose of providing a catalyst which is more resistant to poisoning by sulfur than other catalysts, usually containing nickel, which are generally used in steam reforming process.

This is a provisional obviousness-type double patenting rejection.

Claim (Claims?)19 and 23 is (are?) provisionally rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over claims 1-22 of copending Application No. 09/321,390 in view of in view of Dicks (USP 3,904,554) as applied to claims 1-2, 7, 9, 12-1 8 above, and further in view of Clawson (WO 98/0877 1).

While the copending application do (does?) not explicitly claim said fuel gas being methanol, using methanol as a fuel was well known in the art at the time the invention was made (as evidenced by Clawson (P20/L23-24), the fuel selection being driven by system requirements, such desired finished product composition and by fuel availability and cost.

It would have been obvious to one having ordinary skill in the art at the time the invention was made to use methanol as fuel gas, as taught by Clawson, in a process claimed by 09/321,390, for the purpose of obtaining desired product at optimal process cost.

This is a provisional obviousness-type double patenting rejection.

THE ARGUMENT

The Double Patenting Rejections

These rejections will not be addressed in this appeal brief since they are not ripe for resolution at this point in time.

The §112 Rejections

The claims in this application have been amended after the final rejection in order to overcome the§112 rejections. The amendments have not yet been entered, but the Examiner has indicated that they will be entered upon submission of this appeal brief. Therefore, we will not waste the Honorable Board's time arguing the veracity of these rejections unless the Examiner reiterates these rejections for some reason in her Answer.

We do note, however, that the Examiner has needlessly argued the veracity of prior §112 rejections which were withdrawn in the final rejection. In her argument, she has alleged that she can be considered "one of ordinary skill in the art". We feel compelled to address the Examiner's allegations that she is "one of ordinary skill in the art". We quote her position regarding this point:

> "In response the examiner notes that she can be considered one of ordinary skill in the art, as the art area applicable in the instant invention is that of hydrocarbon reforming, and one of ordinary skill in this art is considered to have at least a BS degree, with additional education in the field and at least 3 years practical experience working in the art; is aware of the state of the art as shown by the references of record, to include those cited by applicants and the examiner (ESSO Research & Engineering v. Kahn & Co., 193 USPQ 582 [1974]) and who is presumed to know something about the art apart from what references alone teach (In re Bode, 193 USPQ 12, (16) [CCPA 1977]); and who is motivated by economics to depart from the prior art to reduce costs.".

Our response to her position is this. There is nothing in the record in this case that indicates that Examiner Ridley has "at least a BS degree"; if she does, there is nothing in the record to indicate what technology her BS degree is in; there is nothing in the record that indicates that Examiner Ridley has at least "3 years of practical experience" in the field of hydrocarbon fuel reforming; and there is nothing in the record of this case to prove that Examiner Ridley knows anything at all about how to "reduce costs" in the field of hydrocarbon fuel reforming.

Should Examiner Ridley further pursue these objection/rejections, then she must be required to prove the truthfulness of the aforesaid allegations relating to her position that she can be considered to be one of skill in the art of hydrocarbon fuel reforming. We submit that such proof would require a declaration or an affidavit by Examiner Ridley which will be made a part of the record as to facts which support her allegation that she is indeed one of ordinary skill in the aforesaid art.

The §103 Rejections

Claim 23:

Claim 23 stands rejected as being obvious over the combination of Clawson, Narumiya et al and Setzer et al '484.

Claim 23 recites a methanol fuel gas autothermal reformer assembly which includes a monolithic open cell foam catalyst bed that includes an inlet portion which is provided with a noble metal catalyst that will combust a portion of the methanol fuel gas at a temperature of about 200°F which enables start up of the reformer assembly.

Clawson discloses a reformer assembly that is able to reform an alcohol fuel gas, and that includes a catalyzed pellet bed which reforms the fuel gas. The Clawson reference discloses a partial oxidation zone 24 prior to the catalyst bed, which zone 24 converts an alcohol fuel stream (such as methanol) to a combination of carbon monoxide, steam and hydrogen gas (see Clawson, page 7,lines 6-9). There is no catalyst in the partial oxidation zone 24 of Clawson. Narumiya et al discloses a device for purification of exhaust gases which includes an oxidizing catalyst deposited on a porous ceramic body. The Narumiya et al device oxidizing catalyst oxidizes, i.e., burns, smelly gases and carbon monoxide found in burner exhaust gases. Setzer et al '484 discloses a high temperature autothermal reforming catalyst for use in steam reforming of a hydrocarbon fuel gas such as natural gas or naphtha. The Setzer et al reformer operates at temperatures above 1,200°F (see FIG. 3).

If one were to combine the teachings of Clawson and Narumiya et al without the benefit of the teachings of the instant application, the result would necessarily include

the oxidizing catalyst bed of Narumiya et al in the reformer of Clawson. This combination of components would, however, be undesirable in an alcohol reformer of the type disclosed in Clawson since, while the oxidizing catalyst would convert the CO in the partially oxidized gas stream of Clawson to CO_2, which would be desirable, the oxidizing catalyst would also burn the hydrogen in the partially oxidized gas stream of Clawson, thus rendering the catalyst bed exhaust gas stream unsuitable for use in a fuel cell, which would be undesirable. This fact has been pointed out to the Examiner and her response was: "the examiner notes that Narumiya et al. was not relied upon to teach using an oxidizing catalyst in a steam reformer. The examiner has however relied on the disclosure of Narumiya et al. to teach a cylindrical monolithic open cell foam structure (Fig. 1, C4/L30-32).".

The Examiners reliance on only a part of Narumiya et al, while ignoring the remainder of the reference, is improper. The Examiner must consider the reference as a whole, and she cannot pick and choose only parts of the teachings of a reference which suit her position and ignore the rest. It is impermissible within the framework of section 103 to pick and choose from any one reference only so much of it as will support a given position, to the exclusion of other parts necessary to the full appreciation of what such reference fairly suggests to one of ordinary skill in the art. See: In re Umbricht, 160 USPQ 15 (CCPA 1968). See also In re Wesslau, 147 USPQ 391 (CCPA).

Regarding the Setzer et al reference, the Examiner states that Setzer et al teaches an inlet portion of a catalyst bed which is provided with a catalyst that is operable to combust a portion of the fuel gas stream at a temperature of about 200°F, citing Col. 4, lines 29-66 of Setzer et al to support her characterization of the capabilities of the inlet portion of the catalyst bed of Setzer et al. The section of the Setzer et al patent referred to by the Examiner discloses absolutely nothing about the start up temperature of the Setzer et al reformer. FIG. 3 of Setzer et al '484 discloses that the inlet portion of the catalyst bed operates at a temperature of more than 1,200°F.

It is quite clear that that Examiner has absolutely no grounds for stating that: "Setzer et al teaches an inlet portion of a catalyst bed being provided with a catalyst which is

operable to combust a portion of the fuel gas stream at a temperature of about 200°F.".

The motivation provided by the Examiner for her Clawson-Narumiya et al-Setzer et al '484 combination is: "for the purpose of allowing greater flexibility in the maximum allowable reactor temperature and the method of introducing the air in the reactor.". This motivational statement is quite nebulous, and where the Examiner found this "motivation" in the three references is not identified by the Examiner. What is meant by: "greater flexibility in the maximum allowable reactor temperature"? This motivational statement pervades this rejection and is not understood and not supported by the these three basic references.

The Honorable Board knows, and the Examiner must know, that the motivation for supporting an allegedly obvious combination of prior art references must be found in the references being relied upon. The motivation to combine or modify must be found in the prior art. See: In re Gordon, 221 USPQ 1125 (Fed. Cir. 1988); In re Fine, 5 USPQ2d 1596 (Fed. Cir. 1988); and In re Fritch, 23 USPQ2d 1780 (Fed. Cir. 1992).

The rejection of Claim 23 is thus flawed in that: 1) the proposed combination of Clawson and Narumiya et al would result in an undesirable fuel reformer and would not be pursued by one skilled in the art; 2) the Examiner's admitted reliance on the Narumiya et al reference is selective and is improper; 3) the Examiner's analysis of the inlet temperatures of the Setzer et al '484 catalyst bed is clearly erroneous; and 4) the motivation for the allegedly obvious combination of the three references put forth by the Examiner is not supported by the prior art that she is relying on and seems to have been conjured up by the Examiner.

The rejection of Claim 23 is thus clearly erroneous and should be reversed.

This point about picking and choosing only so much of Narumiya et al as suits the Examiner's purposes pervades this final rejection, since Narumiya et al is included in each of the rejections.

Claims 1, 2, 7, 9, 12-20 and 22:

Claims 1, 2, 7, 9, 12-20 and 22 stand rejected as being obvious over the combination of Clawson and Narumiya et al and Setzer et al '484 in view of Dicks. The Examiner has prefaced the rejections of these claims with the phrase "as best understood".

The Examiner's reliance on the combination of Clawson-Narumiya et al-Setzer et al '484 in rejecting this claim set is flawed, as argued in connection with the rejection of Claim 23. Thus this argument is reiterated in connection with this rejection.

The Examiner, on page 4 of the final rejection, characterizes Clawson as disclosing a catalyst bed having a first region which is operable to combust a portion of of the fuel gas stream so that the temperature of the fuel gas stream in the first region is raised to a temperature in the range of about 300°F to about 500°F, citing page 24, lines 1-7 and page 5, lines 12-19 of Clawson in support of this analysis.

In fact, the cited portions of Clawson do not suggest any operating temperature for the partial oxidation zone 24 (which the Examiner refers to as "the first region") of the Clawson reformer. Page 12, lines 4-6 of Clawson states that the operating temperature of the partial oxidation zone 24 is in the range of about 950°C to about 1,150°C, which is equivalent to a temperature range of about 1,742°F to about 2,102°F.

The Examiner's analysis of Clawson is thus clearly erroneous and does not support the rejection. The Examiner's reliance on Clawson for suggesting the claimed temperature range recited in Claims 1, 2, 7, 9, 12-19 and 22 is clearly erroneous.

All of the claims rejected in this section of the final rejection rely on the Dicks reference as a solution to a problem of sulfur contamination of a catalyst such as nickel from the fuel being reformed. We would like to point out to the Honorable Board and to the Examiner that there is no sulfur in ethanol or methanol. Thus the problem that the

Examiner is solving with the combination of references does not exist in the claimed reformer.

The claims in this application are all limited to an ethanol and/or methanol fuel gas reformer. Thus the motivation offered by the Examiner for modifying the three basic references by including the Dicks catalyst to solve a problem of sulfur contamination in the claimed reformer assembly solves a problem that does not exist in the claimed reformer assembly, and the motivation for making the modified combination is spurious. One would not modify a reference, or a combination of references, in order to solve a problem that does not exist in the claimed subject matter.

Additionally, the Examiner surmises that a copper or zinc based catalyst would be more resistant to sulfur contamination than a nickel catalyst, without any support for this conjecture. The burden of proof for any allegation of obviousness rests with the Examiner and the Examiner's burden of proof must be discharged.

In Ex parte Levy, 17 USPQ2d 1461 (US PTO Bd. Pat. App. & Int. 1990), the Board held that the initial burden of establishing a *prima facie* basis to deny patentability rests upon the examiner. See also In re Carleton, 202 USPQ 165 (CCPA 1979); and In re Piasecki, 223 USPQ 785 (Fed. Cir. 1984). This burden can only be discharged by establishing a factual basis for the finding of non-patentability. Examiner's conjecture or conclusionary assertions do not provide the necessary factual basis.

Claims 1, 2, 7, 9, 12-19 and 22 all recite the heat exchange relationship between the air inlet passage and the process gas stream whereby heat will be transferred from the process gas stream to the air inlet passage. In the rejection, the Examiner has taken the position that Clawson discloses such a heat exchange relationship. In this regard, the Examiner has stated that: "Regarding claim(s) 22 Clawson discloses a similar autothermal reformer assembly (Fig. 3), the assembly comprising:
a) a catalyst bed (200), said catalyst bed including an inlet end (210) and an outlet end (270), an inlet portion of said catalyst bed being operable to combust a portion of the fuel gas thereby enabling start up of the reformer assembly while inhibiting carbon

deposition in catalyzed cells of said foam catalyst bed (P24/L1-7 & P5/L12-19);
b) a fuel gas stream inlet passage (208), said fuel gas stream inlet passage (208) being disposed in heat exchange relationship with a process gas stream outlet passage from said catalyst bed whereby heat is transferred to said fuel gas stream inlet passage from the processed gas stream (P20/L7-11 & P21/L7-10);
c) an air inlet passage (232), said air inlet passage being disposed in heat exchange relationship with the process gas stream whereby heat from the process gas stream is transferred to said air inlet passage (P22/13-15); and
d) a fuel gas stream reforming catalyst (225) deposited in said catalyst bed (200)." (see paper # 6).

The Examiner's characterization of details of the Clawson structure is incorrect. The fuel gas inlet line in Clawson is denoted by the numeral 219, not 208. The numeral 208 denotes the initial portion of the catalyst bed and is filled with a catalyst 214. The fuel comes from a source 217, passes through the line 219 and enters the initial portion 208 of the catalyst bed. Oxygen (air) enters the reformer 200 through a line 235 from an oxygen source 242. The air passes through a helical tube 232 which is disposed in an annular chamber which doesn't seem to numbered. The partially reformed gas stream passes through the annular chamber and then passes into a second catalyst bed 262. Thus, the air stream in the helical tube 232 is disposed in heat exchange relationship with the partially reformed gas stream, but the fuel gas inlet passage 219 is not disposed in heat exchange relationship with the partially reformed gas stream. Thus, preheating of the fuel gas stream, as claimed in this application, does not occur in Clawson.

The Examiner further states: "Fig. 3 of Clawson shows a passage 208 in heat exchange relationship with passage 224. A gas stream to be reformed by catalyst 225 contained in said passage 224 to form processed gas enters through said passage 208, therefore said passage 208 is a fuel gas inlet passage.

Further the examiner notes that the instant claim language: 'a hydrocarbon fuel gas autothermal reformer assembly comprising (...)' does not distinguish between the

instant invention and the reformer assembly disclosed by Clawson, as said language does not exclude reformer assemblies wherein a fuel gas inlet passage further comprises a catalyst.

Additionally, the examiner would like to point out that passage 219 is also in heat exchange relationship with processed fuel gas stream outlet passage 224, as passage 219 comes in contact with reformer 200 and reformer 200 comprises passage 224. Therefore there is a heat exchange between said passages 219 and 224.

In response to applicant's argument that the references fail to show certain features of applicant's invention, the examiner notes that the features upon which applicant relies (i.e., preheating of the fuel gas) are not recited in the rejected claim(s), as said claims merely recite heat exchange relationship, 'whereby heat will be transferred to said fuel gas inlet passage from the processed gas stream'. Although the claims are interpreted in light of the specification, limitations from the specification are not read into the claims. See In re Van Geuns, 988 F. 2d 1181, 26 USPQ2d 1057 (Fed. Cir. 1993)." (see paper # 6).

The Examiner's allegation that the phrase "whereby heat will be transferred to said fuel gas inlet passage from the processed gas stream" does not require preheating of the fuel gas stream is tantamount to her ignoring the contents of the "whereby" statement contained in the claims in question. This constitutes disregarding a limitation contained in the claims in question, which is improper. It is error to ignore specific claim limitations distinguishing over the disclosures of the references relied upon by an examiner in rejecting claims. See: In re Glass, 176 USPQ 489 (CCPA 1973); and In re Chandler, 117 USPQ 361 (CCPA 1958). In determining patentability, functional language, preambles, **and language in "whereby", "thereby", and "adapted to" clauses cannot be disregarded**. Pac-Tec, Inc. v. Amerace Corp., 14 USPQ2d 1871 (CAFC 1990).

The Examiner's rejections of Claims 1, 2, 7, 9, 12-20 and 22 are thus erroneous for the reasons noted above, and should be reversed by the Honorable Board.

Claims 13-15

Claims 13-15 have been rejected as being obvious over the combined teachings of Clawson in view of Narumiya et al and further in view of Setzer '484 and Dicks, and still further in view of Sheller. It is noted that Sheller relates to a catalytic converter for burning pollutants in an internal combustion engine exhaust stream. The Examiner has alleged that the catalyst bed in Sheller is a monolith, quoting the Examiner: "Further, the examiner notes that Sheller, in C1/L53-C2/L16 in fact does teach a monolithic catalyst bed, wherein: said catalyst bed includes a metal support selected from the group consisting of stainless steel, nickel alloys and iron-aluminum alloys (C I /L26-29); said metal support is connected to a source of electrical current, so as to serve as a resistance heating element (C1/L52-63); said metal support is electrically heated to operating temperature within about twenty seconds of applying electrical current thereto (C1/L65-66).". Sheller itself belies this allegation in the very sections cited by the Examiner. The text in Col. 1, lines 53+ of Sheller discusses prior art monolith catalyst beds, and the patent goes on to state that these devices when electrically heated prove unsatisfactory (Col. 2 lines 50+). Sheller suggests that a catalyst bed must be formed from a plurality of corrugated metal strips 10 on which the catalyst is deposited in order to be electrically heatable. Sheller suggests that if the catalyst bed were formed from a monolith then it could not be satisfactorily electrically heatable due to the low electrical resistance of a monolithic catalyst bed (see Col. 2, lines 50-66). Thus the combination of the teachings of the four references as strung together by the Examiner would suggest that if one wanted to electrically heat a catalyst bed which is formed from an electrically conductive core, then the core could not be a monolithic core. The combination of references cited thus teaches away from the subject matter of Claims 13-15. The addition of the Sheller reference to the

We note that the Narumiya et al reference is being once again selectively dissected in putting forth the grounds for the final rejection. This is improper, as noted above, and is clearly erroneous.

This rejection is thus improper, and should be reversed by the Honorable Board.

Claim 18

We agree that the recitation of an air/steam mixture in the air inlet passage does not render the subject matter of Claim 18 patentable, in and of itself. The addition of the Bhattacharyya et al reference to the mix does not, however, cure the deficiencies of the other four references used in the rejection, which deficiencies are discussed in detail above.

In formulating the grounds for the rejections of the aforesaid claims, the Examiner has offered speculative motivation for modifying the subject matter of Clawson with the teachings of Narumiya et al and Setzer et al '484. Obviousness cannot be established by modifying the teachings of the prior art to produce the claimed invention, absent some teaching or suggestion supporting the modification. Under 35 USC 103, teachings of references can be combined only if there some suggestion or incentive to do so. **The motivation to combine or modify must be found in the prior art.** See: In re Gordon, 221 USPQ 1125 (Fed. Cir. 1988); In re Fine, 5 USPQ2d 1596 (Fed. Cir. 1988); and In re Fritch, 23 USPQ2d 1780 (Fed. Cir. 1992).

The Examiner has failed completely to point to anything in the three basic references that supports her position that the combination would allow: "greater flexibility in the maximum allowable reactor temperature and the method of introducing the air into the reactor." (whatever that means). Where does this alleged motivation come from in the prior art?

Non-analogous arts:

We submit that Narumiya et al and Sheller are directed to arts which are non-analgous arts, as that concept in used in connection with patent law. The inquiry as to whether disparate arts are "analogous arts" must be clearly focused in order to conform to MPEP guidelines and case law. The Honorable Board's attention is directed to §2141.01(a) of the MPEP for guidance in this area of the law. The MPEP directs our attention to the "problem" an inventor is attempting to solve, when considering whether

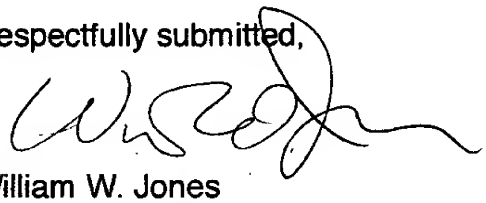
one teaching relates to an art that is analogous to a teaching in a disparate art. The test for analogous arts, and has characterized the test as being: "a prior art reference +++ must be reasonably pertinent to the particular problem with which the applicant was concerned, in order to be relied upon as a basis for the claimed invention.". In the instant case, three prior art references, Clawson, the Setzer reference, are concerned with hydrocarbon fuel gas reforming, as is the applicant here, while the Narumiya et al reference and the Sheller reference are concerned with the conversion of noxious compounds in an exhaust gas stream to innoxious compounds by burning the noxious compounds in a catalytic converter. Applicant is concerned with the catalytic reforming of a hydrocarbon fuel gas. The problem of reforming a hydrocarbon fuel gas relates to minimal burning of components of the fuel gas so as to preserve the hydrogen content, and the problem of detoxifying an exhaust gas stream relates to maximized burning of the components of the gas stream. These are not analogous problems. The two catalytic converter references cited by the Examiner do not suggest the commonality of the two disparate problems in the systems described in the references.

The Honorable Board is thus respectfully requested to recognize the fact that the art of reforming a hydrocarbon fuel gas and the art of detoxifying an exhaust gas are disparate and non-analogous arts under the guidelines established by the USPTO.

SUMMARY

For the reasons advanced above, the Honorable Board is respectfully requested to reverse the final rejections of Claims 1, 2, 7, 9, 12-20, 22 and 23, or any individual ones of these claims.

Respectfully submitted,



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I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to the Commissioner of Patents and Trademarks, Washington, D.C. 20231, on

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(9) APPENDIX:

1. A methanol and ethanol fuel gas autothermal reformer assembly for converting a methanol or ethanol fuel gas stream into a hydrogen-enriched process gas stream, said assembly comprising:

a) a monolithic open cell foam catalyst bed, said catalyst bed including an inlet end and an outlet end, a first inlet region of said catalyst bed being provided with a catalyst which is operable to combust a portion of the fuel gas stream so as to raise the temperature of said fuel gas stream in said first region to a temperature in the range of about 300° to about 500°F while inhibiting carbon deposition in catalyzed cells of said foam catalyst bed, and said catalyst bed further including a subsequent second region which contains a copper and/or zinc catalyst;

b) a fuel gas stream inlet passage, said fuel gas stream inlet passage being disposed in heat exchange relationship with a process gas stream outlet passage from said catalyst bed whereby heat is transferred to said fuel gas stream inlet passage from the processed gas stream;

c) an air inlet passage, said air inlet passage being disposed in heat exchange relationship with the process gas stream whereby heat from the process gas stream is transferred to said air inlet passage; and

d) a fuel gas stream reforming catalyst deposited in said foam catalyst bed.

2. The autothermal reformer assembly of Claim 1 wherein said catalyst in said first region of said catalyst bed includes a noble metal and calcium oxide.

7. The autothermal reformer assembly of Claim 1 wherein said first region of said foam catalyst bed contains an iron oxide catalyst in combination with calcium oxide.

9. The autothermal reformer assembly of Claim 2 wherein said noble metal catalyst is a catalyst selected from the group consisting of platinum, palladium and rhodium, and mixtures thereof.

12. The autothermal reformer assembly of Claim 1 wherein said foam catalyst bed

includes at least one ceramic foam support body.

13. The autothermal reformer assembly of Claim 1 wherein said foam catalyst bed includes an autothermal reformer-operating temperature-compatible metal support selected from the group consisting of stainless steel, nickel alloys and iron-aluminum alloys.

14. The autothermal reformer assembly of Claim 13 wherein said metal support is connected to a source of electrical current so as to serve as a resistance heating element during start-up of said reformer assembly.

15. The autothermal reformer assembly of Claim 14 wherein said metal support is electrically heated to operating temperatures within about twenty seconds after applying electrical current thereto.

16. The autothermal reformer assembly of Claim 1 wherein said catalyst bed is cylindrical in shape.

17. The autothermal reformer assembly of Claim 1 wherein said fuel gas stream inlet passage contains a fuel gas/steam mixture.

18. The autothermal reformer assembly of Claim 1 wherein said air inlet passage contains an air/steam mixture.

19. The autothermal reformer assembly of Claim 1 wherein said fuel gas is methanol.

20. A methanol fuel gas reformer assembly comprising:
a) a cylindrical monolithic open cell foam catalyst bed, said catalyst bed including an inlet end and an outlet end;
b) a fuel gas/steam mixture inlet passage; and
c) fuel gas reforming catalysts deposited in said cylindrical foam catalyst bed, said catalysts including an inlet section noble metal catalyst and a subsequent copper

and/or zinc catalyst.

22. A methanol and ethanol fuel gas autothermal reformer assembly for converting a methanol or ethanol fuel gas stream into a hydrogen-enriched process gas stream, said assembly comprising:
a) a monolithic open cell foam catalyst bed, said catalyst bed including an inlet end and an outlet end, an inlet portion of said catalyst bed being provided with a noble metal catalyst which is operable to combust a portion of the fuel gas stream at a temperature of about 200°F thereby enabling start up of the reformer assembly while inhibiting carbon deposition in catalyzed cells of said foam catalyst bed;
b) a fuel gas stream inlet passage, said fuel gas stream inlet passage being disposed in heat exchange relationship with a process gas stream outlet passage from said catalyst bed, whereby heat is transferred to said fuel gas inlet passage from the process gas stream;
c) an air inlet passage, said air inlet passage being disposed in heat exchange relationship with the processed gas stream whereby heat from the process gas stream is transferred to said air inlet passage; and
d) a fuel gas reforming copper and/or zinc catalyst deposited in said foam catalyst bed.

23. A methanol fuel gas autothermal reformer assembly for converting a methanol fuel gas stream into a hydrogen-enriched process gas stream, said assembly comprising a monolithic open cell foam catalyst bed, said catalyst bed including an inlet end and an outlet end, an inlet portion of said catalyst bed being provided with a noble metal catalyst which is operable to combust a portion of the methanol fuel gas at a temperature of about 200°F thereby enabling start up of the reformer assembly while inhibiting carbon deposition in catalyzed cells of said foam catalyst bed.